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Hooked galaxies & exploding stars

SK Bhasin points to a region far, far away and why an amazing trio so amazes astronomers

GIVEN the technological advances, it's amazing what tedious observations of phenomena light years removed from our world can throw up. Namely, that some galaxies get so close to their neighbours that they get rather distorted and that such encounters also have the effect of spawing new generations of stars — some of which explode. The European Southern Observatory's Very Large Telescope has obtained a unique vista of a pair of entangled galaxies in which a star exploded.

Because of the importance of exploding stars for cosmological studies (relating to claims of an accelerated cosmic expansion and the existence of so called "Dark Energy" (a new, unknown constituent of the universe) they are a preferred target for astronomical study. Thus, on several occasions, do astronomers point the ESO's VLT towards a region of the sky that portrays a trio of amazing galaxies.

MCG-01-39-003 (Fig 1) is a peculiar spiral galaxy that presents a hook at one side, most probably because of the interaction with its spiral galaxy neighbour NGC 5917 (also known as MCG-01-39-002.) In fact, further enhancement of the image revealed that matter was pulled off MCG-01-39-003 by NGC 5917. Both these galaxies are located at similar distances, about 87 million light-years away, towards the constellation of Libra.

NGC 5917 is about 750 times fainter than can be seen by the unaided eye and it's about 40,000 light years across. It was discovered in 1835 by William Herschel who, strangely enough, seems to have missed its hooked companion, only 2.5 times fainter.

Note also the still fainter and nameless but intricately beautiful, barred spiral galaxy (at the bottom left of Fig 1) as it looks from a distance at the entangled pair while many "island universes" do a cosmic dance in the background.

But this is not the only reason why astronomers observe this region. Last year, a star exploded in the vicinity of the hook. The supernova — called SN 2005cf because it was the 84th found that year — was discovered by astronomers Evan Pugh and Weidong Li with the robotic KAIT telescope on 28 May. It appeared to be projected on top of a bridge of matter connecting MCG-01-39-003 with NGC 5917. Further analysis with the Whipple Observatory's 1.5-metre telescope showed this supernova to be of Type 1a (this type lack helium and present a silicon absorption line in their spectra near peak light. The most commonly accepted theory of these type of supernovae is that they are the result of a carbon-oxygen white dwarf accreting matter from a nearby companion star, typically a red giant, until it reaches the Chandrasekhar limit. The increase in pressure raises the temperature near the centre, and a period of convection lasting approximately 100 years begins. At some point in this simmering phase, a deflagration flame front powered by fusion is born, although the details of the ignition — the location and number of points where the flame begins — is still unknown. This flame accelerates dramatically, through the Rayleigh-Taylor instability and interactions with turbulence. It is still a matter of considerable debate as to whether this flame transitions from a subsonic deflagration into a supersonic detonation) and that the material was ejected with velocities of up to 15 000 km per second (54 million km per hour!).

Immediately after the discovery, the European Supernova Collaboration, led by Wolfgang Hillebrandt started an extensive observing campaign on this object, using a large number of telescopes around the world. There have been several indications about the fact that galaxy encounters and/or galaxy activity phenomena may produce enhanced star formation. As a consequence, the number of supernovae in this kind of system is expected to be larger with respect to isolated galaxies. Normally, this scenario should favour mainly the explosion of young, massive stars. Nevertheless, recent studies have shown that such phenomena could increase the number of stars that eventually explode as Type Ia supernovae, which most interest astronomers.

For this reason, the discovery of SN2005cf close to the "tidal bridge" between MCG-01-39-002 and MCG-01-39-003 constitutes a very interesting case. The supernova was followed by the ESC team during its whole evolution, from about 10 days before the object reached its peak luminosity until more than a year after the explosion. As the SN becomes fainter and fainter, larger and larger telescopes are needed. One year after the explosion, the object is indeed about 700 times fainter than at maximum.

The supernova was observed with the VLT equipped with FORS1 by ESO astronomer Ferdinando Patat, who is also member of the team led by Massimo Turatto (Padua, Italy), and at a latter stage by the Paranal Science Team, with the aim of studying the very late phases of the supernova. These late stages are very important to probe the inner parts of the ejected material in order to better understand the explosion mechanism and the elements produced during the explosion.

The deep FORS1 images revealed a beautiful tidal structure in the form of a hook, with a wealth of details that probably include regions of star formation triggered by the close encounter between the two galaxies. "Curiously, the supernova appears to be outside of the tidal tail," said Ferdinando Patat. "The progenitor system was probably stripped out of one of the two galaxies and exploded far away from the place where it was born."

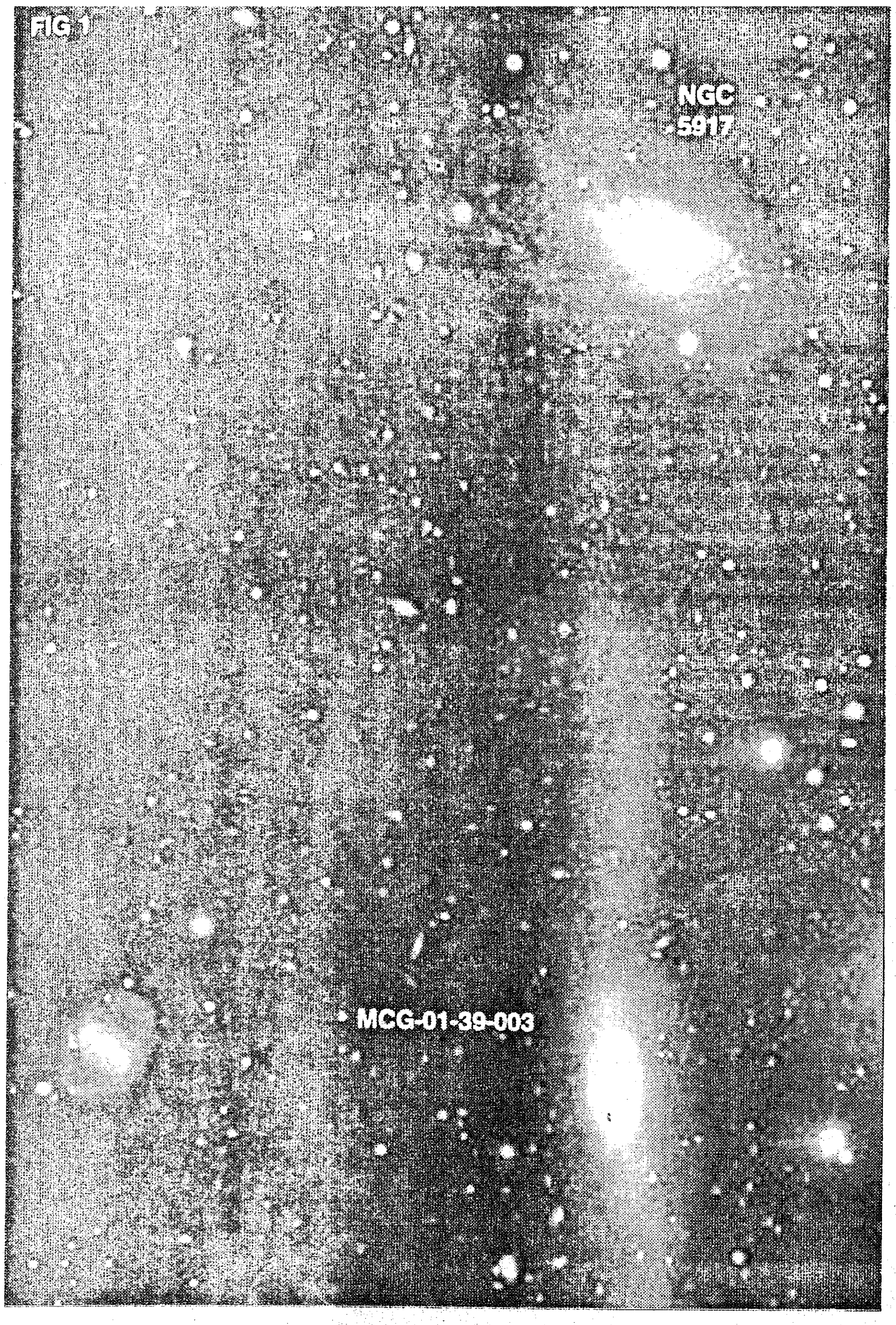
Meanwhile, the National Aeronautics and Space Administration's Chandra X-Ray Observatory has revealed a new generation of stars spawned by a super-massive black hole at the centre of the Milky Way galaxy. This novel mode of star formation may solve several mysteries about these super-massive black holes that reside at the centres of nearly all galaxies.

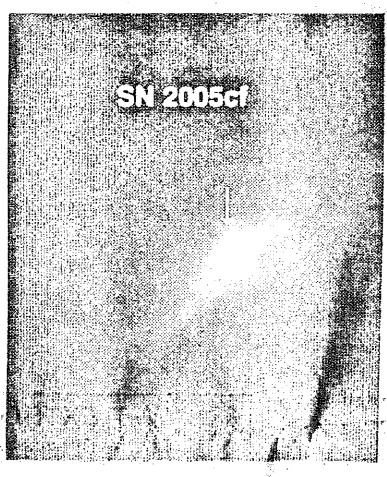
"Massive black holes are usually known for violence and destruction," said Sergei Nayakshin of the University of Leicester in the UK. "So it's remarkable this black hole helped create new stars, not just destroy them."

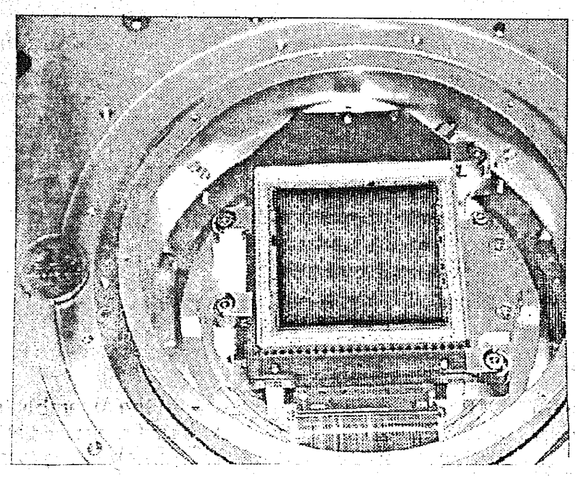
Black holes have earned their fearsome reputation because any material, including stars, that falls within their "event horizon" is never seen again. These new results indicate that immense disks of gas, orbiting many black holes at a safe distance from the event horizon, can help nurture the formation of new stars. This conclusion comes from new clues that could only be revealed in X-Rays. Until the latest Chandra results, researchers hade disagreed about the origin of a mysterious group of massive stars discovered by infrared astronomers.

The stars orbit less than a light year from the Milky Way's central black hole, which is known as Sagittarius A*. At such close distances to Sagittarius A*, the standard model for star forming gas clouds predicts they should have been ripped apart by tidal forces from the black hole. Two models, based on previous research to explain this puzzle, have been proposed. In the disk model, the gravity of a dense disk of gas around Sagittarius A* offsets the tidal forces and allows stars to form. The research suggests the rules of star formation change when stars form in the disk surrounding a giant black hole. Because this environment is very different from typical star formation regions, there is a change in the proportion of stars that form. For example, there is a much higher percentage of massive stars in the disks around black holes.

(The author is a freelance contributor)







EYE ON THE SKY: The ESO's VLT equipped with FORS1 that located SN 2005cf